### Sensor Module

## BACKGROUND OF THE INVENTION

# 5 <u>1. Field of the Invention:</u>

The present invention relates to a module made of one or more semiconductor sensors, such as a temperature sensor, a tire pressure sensor, an acceleration sensor, a rotation speed sensor, a steering angle sensor, etc., in a flexible housing as it can, among other things, be vulcanized into rubber tires.

# 2. Description of the related art:

In order to increase the operational safety of vehicles of 15 all kinds, the development of technical assemblies for monitoring most varied properties of the wheels and tires has been worked on for a long time. In this context, properties to be monitored can be the temperature, the internal pressure, the deformation, the acceleration, the 20 tilt angle etc. of the wheels or tires. Changes on the wheels and tires caused by the usage and wear are to be recognized to avoid accidents or at least minimize the risk of accidents. Especially in the area of passenger transport, such as at aircraft tires, bus tires, or railway 25 wheels monitoring the tires and wheels could bring much more safety.

From Proc. IEEE 1998 MMT/AP International Workshop on Commercial Radio Sensor and Communication Techniques, pages 83 to 96, the use of surface wave sensors for the detection of the deformation of the tires is known. The cause of the deformation, however, such as temperature, internal tire pressure, or outside influences, are not detected herewith. The detected signal may then be transmitted to a vehicle mounted receiver unit in a wireless manner, for example inductively or by radio.

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Another solution for the detection of the tire deformation is described in EP 1 186 853 A2. Here, the profile is impressed into the side wall of the rubber product, and the deformation of this profile by influences, such as internal tire pressure or also outside influences, for example by the road conditions, is measured in various ways. Possible principles for the detection of the profile deformation are the capacitive measurement, the optical measurement, measurement by ultra-sound, and also the measurement by eddy current.

Independent of the kind of the implementation of the sensor in the tire, the requirement every system has to meet is the wireless transmission of the measurement data from the wheel or tire to the vehicle. Suitable transmission methods hereof are the inductive transmission, the transmission by means of electromagnetic waves in the infrared region, or also the transmission by radio.

Due to the high weight and rigidity of the housing, the sensors are in most cases currently being mounted near the rim. The current supply, for example by means of batteries, or the assemblies for the wireless data transmission, such as induction coils or antennas, currently also have to be worked into the tire element separate from the sensor itself.

#### SUMMARY OF THE INVENTION

It is the object of the present invention to provide a sensor module in a flexible housing, wherein the transmission means is integrated in the module.

Furthermore, a method for the production of such a sensor module is provided.

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The present invention is a sensor module having at least one sensor element that is at least partially surrounded by

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taken in conjunction with the accompanying drawing, in which:

Figure 1 shows components of a sensor module with a flexible housing.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows an exemplary embodiment of a sensor module 10 with a flexible housing. The sensor module according to figure 1 consists of a support film 2, a stand-off 3, said stand-off 3 having recesses that can accommodate the sensor element(s) 1, and a metalized cover film 5 with contact element 7 and an integrated transmission element 6. 15 Depending on the application of the sensor module, one or more semiconductor devices and/or sensors may be integrated in the module. Likewise, it is also possible to integrate signal processing integrated circuits apart from the sensors in the module. Depending on the spatial condition, 20 the operating voltage may be generated in the module itself, e.g. by means of batteries, or inductively coupled in.

In an advantageous method for the production of the sensor 25 module illustrated in figure 1, the film 3 with its recesses for the accommodation of the sensor/semiconductor devices is applied onto a support film 2. In these recesses, the sensor elements 1 are mounted. In order to establish the mechanical and thermal contact, a fixing 30 agent is required that adheres to both the semiconductor body, e.g. silicon, and the support material, the film. For example, epoxy or silicon-based glues are suitable, if necessary with an activator previously applied to the film. The so-far produced module is then completed with a cover 35 and contact film 5. Said cover and contact film 5 is coated with a conductive and suitably structured layer, e.g. aluminum or copper, so that both the sensor/semiconductor

elements 1 may be contacted and the transmission means 6, e.g. the antenna, is already realized by the conductive layer.

5 Instead of the film 3 utilized as stand-off, it is also possible to use a support film with integrated depressions for the accommodation of the semiconductor devices.

A possible application of such a flexible semiconductor 10 module would be the use as transponder-based tire pressure measuring system. Here, the complete module could be vulcanized into the tire, and the data could be transmitted by means of a standardized receiver unit. The transmission may herein be made via radio or inductively, for example. 15 Apart from sensor elements, other semiconductor devices, such as signal processing integrated circuits, may also be integrated in the sensor module. Such signal processing circuits then have the task to process the signals of various sensors, for example temperature, pressure, or 20 humidity sensors, or also calibration data of the sensors, in order to have to transmit only one signal incorporating all the information to the receiver unit. Likewise, it is possible to integrate, apart from the sensor elements, memory elements in the sensor module. In such storage 25 modules, information, such as identification numbers, age features, mileage readings, date of purchase, dealer, etc., could then be held.